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CATTLE-FEVER TICKS and METHODS of ERADICATION

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THE ERADICATION of the cattle tick from the Southern States is a problem of prime importance to the agricultural welfare of the entire country.

The elimination of the tick will give a very great impetus to the cattle and dairy interests, especially of the South, where agriculture will be placed on a more scientific and profitable basis.

Although the eradication of the tick will be of greatest advantage to the States in which ticks are found, the benefits will be enjoyed also by all other sections. In consequence the problem, in large measure, is one of national importance.

A number of publications on the cattle tick, its habits, and methods of eradication have been issued by the United States Department of Agriculture and by various investigators in the Southern States. This bulletin, prepared for the use of farmers, stockmen, and other interested persons, brings together, from the various sources, practical and useful information regarding the tick and its eradication. It supersedes Bureau of Animal Industry Circular 207 and Farmers' Bulletins 498 and 603, which are no longer available for distribution.

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief
Washington, D. C. October, 1919

CATTLE-FEVER TICKS AND METHODS OF ERADICATION.

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CONTENTS.

	Page.
Progress in tick eradication	3
Reasons for eradicating the cattle tick	4
Life history of the tick	6
Development on the ground	6
Development on cattle	11
Summary of life history	11
Methods of eradication	11
Dipping	12
Pasture rotation	17
Arsenical dips	21
Properties of substances used in making arsenical dips	21
General composition of dips	23
Making the S–B dip	24
Making the boiled dip	26
Diluting the dip to form a bath	27
Replenishing the bath and correcting its strength	29
Precautions in the use of arsenic and arsenical dips	31

PROGRESS IN TICK ERADICATION.

THE Bureau of Animal Industry, in cooperation with the State authorities, is conducting tick-eradication work in the region infested by the cattle tick, as shown in the map (figure 1). From 1906, when this cooperative work was first undertaken, to December 1, 1918, a total of 458,529 square miles was released from Federal quarantine which had been established to control the situation, and in considerable additional area the work is well under way. The territory already released from quarantine exceeds the combined areas of the following block of States: Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, and Louisiana. This record alone should be ample proof of the feasibility of eradicating the tick from the entire infested area, and is evidence of the effectiveness of the methods adopted.

The methods of eradication have been improved upon from time to time as new facts became known, and it may be stated that the methods have reached such a degree of perfection and have had such a wide, practical test, that the question of how to eradicate ticks is no longer an essential part of the problem. The main part of the task is to secure hearty, vigorous, and conscientious cooperation of the people. In other words, the work will progress just as rapidly as the people desire that it shall.

[1] Author's note.—Much of the information in this bulletin relating to the life history of the tick and methods of eradication has been taken almost verbatim from Farmers' Bulletin 498, by H. W. Graybill, with slight revisions by B. H. Ransom, chief of the Zoological Division of the bureau. Robert M. Chapin, of the Biochemic Division, prepared that portion of the bulletin relating to arsenical dips.

REASONS FOR ERADICATING THE CATTLE TICK.

Various kinds or species of ticks occur on cattle in the Southern States, but the one that chiefly concerns us here is that commonly called the "cattle" or "Texas-fever" tick (*Margaropus annulatus*). It is the one most frequently found on cattle in the South and is much more abundant than any of the other species. When the losses caused by this parasite are once thoroughly understood by farmers and stockmen arguments in favor of tick eradication will not be needed. Some of the losses are not directly noticeable and consequently make little impression, while others properly chargeable to the tick are frequently attributed to other causes.

It is hardly necessary to emphasize that the tick is something more than a simple parasite drawing blood from its "host," the name commonly given the animal on which a parasite lives. The tick is also the carrier of a dangerous microorganism, or germ, which it transmits to the blood of cattle, thus causing a disease known by many names, among which are Texas fever, tick fever, splenetic fever, and murrain.[1] Without the tick there can be no tick fever, and by stopping the spread of the tick beyond its natural bounds the fever has been prevented from waging destruction among northern cattle, which are especially susceptible to the disease. In order to restrict the distribution of the tick the National and State Governments maintain quarantine areas, marking the boundaries between the States or portions of States harboring the pest and those that do not (see figure 1). Cattle may be moved out of the quarantined areas only in accordance with the regulations of the Secretary of Agriculture to prevent the spread of splenetic fever of cattle.

The Bureau of Animal Industry has received hundreds of letters from farmers and other interested persons, all residents of the southern territory which has been freed from ticks, testifying to the benefits derived from the destruction of the pest. The consensus of opinion in these letters indicates that on the average cattle are enhanced in value about $10 a head, they weigh one-fifth more, they grade one-fourth better, and they are safe from tick fever and from the shrinkage which it causes. It is also stated that the cattle industry in the South is increasing, that there is an increase in improved blood, that the milk yield of cows is increased about one-fourth, and that there is an increase of forage crops and silos.

The South needs more and better live stock and a larger and better dairy industry, and these objects are being promoted greatly by the destruction of the tick. More than that, the increased production of live stock, by reason of its important influence in maintaining and

[1] For information on this disease and how it is transmitted by ticks, see Farmers' Bulletin 569, "Texas or Tick Fever."

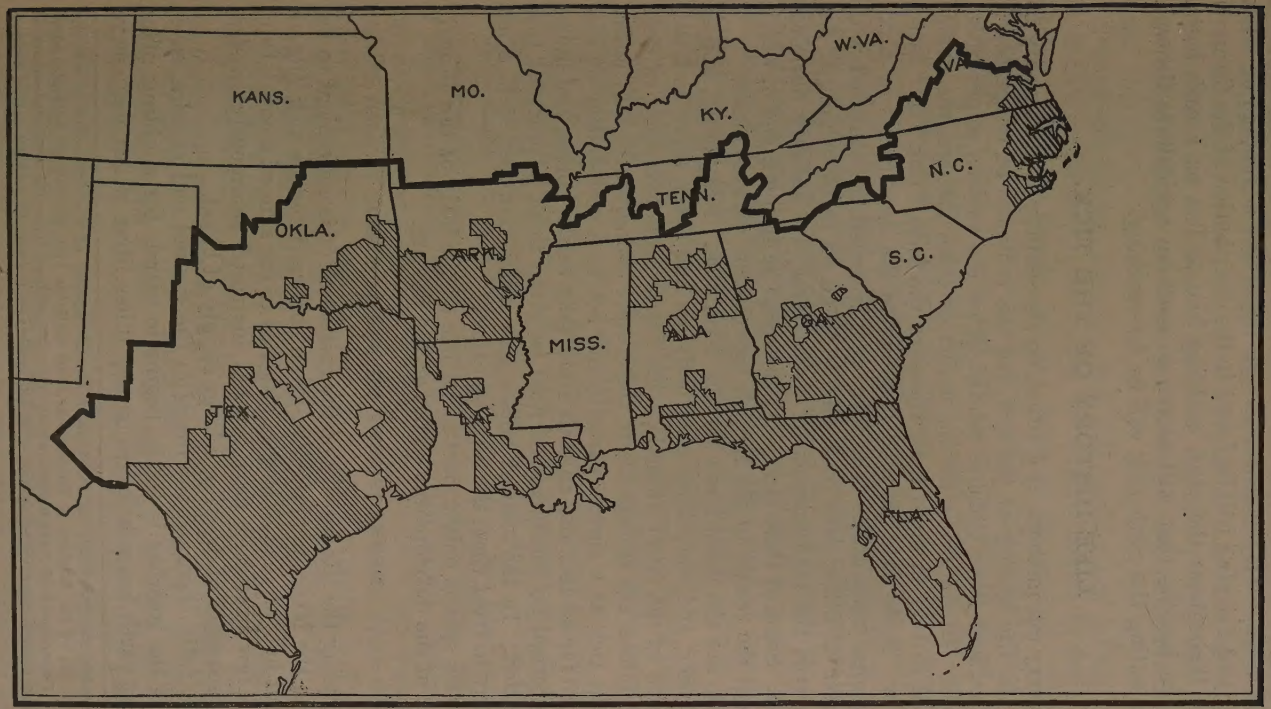

FIG. 1.—Map showing areas quarantined on account of tick fever and areas freed from ticks on December 1, 1918. Shaded portions indicate areas under quarantine; the heavy line shows boundary of infected area at beginning of tick eradication in 1906; white area below heavy line indicates territory that has been freed from ticks and released from quarantine. California, a part of which was originally quarantined but has been free since 1916, is not shown on the map.

improving soil fertility, is of distinct benefit in increasing the yield of field crops. An incidental though important advantage of stock raising and dairying will be found in the distribution of the farmer's income throughout the year, enabling him to live on a cash basis. Thus the benefits that will accrue to southern agriculture through exterminating the cattle tick will be far-reaching.

LIFE HISTORY OF THE TICK.

To carry out methods of eradication successfully it is necessary to know the life history of the tick and the influence of temperature, moisture, and other climatic conditions on the various stages of its existence. In following the discussion of these matters, the reader is asked to bear in mind that whenever the term "tick" or "cattle tick" or "fever tick" is used it refers to the one species or kind, *Margaropus annulatus*.[1] The fever tick is sometimes confused with a number of other ticks occasionally found on cattle which, so far as concerns the transmission of Texas fever, are entirely harmless to them. Some of these ticks are illustrated in figures 2 and 3, which will help the reader to distinguish between the various kinds.

Cattle are the usual hosts for the fever tick. Frequently, horses, mules, deer, and sometimes even buffaloes and sheep serve as hosts. But none of the latter animals, with the possible exception of deer and buffaloes, are susceptible to tick fever; consequently they suffer from the tick as a simple parasite and not as a transmitter of disease. So far as deer and animals other than cattle, horses, and mules are concerned no consideration need be given them in practical tick eradication. In the case of horses and mules, however, it is often necessary to treat them the same as cattle.

The tick spends only a part of its life on the body of the animal; the rest of the development occurs on the pasture.

DEVELOPMENT ON THE GROUND.

In tracing the life history of the cattle tick it is convenient to begin with the large, plump, olive-green engorged female tick (figure 4), about half an inch in length, attached to the skin of a cow. During the few preceding days she has increased enormously in size, as a consequence of drawing a large supply of blood.

When fully engorged she drops to the ground and at once, especially if the weather is warm, begins to search for a hiding place on moist earth beneath leaves or any other litter which may serve

[1] The reader desiring fuller information on the life history of the cattle tick is referred to Bulletin 72, of the Bureau of Entomology, and Bulletin 130, Bureau of Animal Industry, U. S. Department of Agriculture, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15 and 10 cents, respectively.

as a protection from the sun and numerous enemies or shield her from unfavorable conditions. The female tick may be devoured by birds, or destroyed by ants, or may perish as the result of low temperature, absence or excess of moisture, and many other unfavorable conditions; so that many which fall to the ground die before they lay eggs.

During the spring, summer, and fall months egg laying begins in from 2 to 20 days, and during the winter months in from 13 to 98 days, after the female tick has fallen to the ground. The eggs are small, elliptical-shaped, at first of a light-amber color, later changing to a dark brown, and are about one-fiftieth of an inch in length. As the eggs are laid they are coated with a sticky secretion, which causes them to adhere in clusters and no doubt keeps them from drying out. During egg laying the body of the mother tick gradually shrinks, and finally is reduced to about one-third or one-fourth its original size. Egg laying is greatly influenced by temperature, being retarded or even arrested by cold weather. In the summer time egg laying may be completed as soon as 4 days after it has begun, or by the end of about a week after the tick has dropped to the ground. It has been observed that if the ticks drop in the fall of the year the egg-laying process may continue for as long as 151 days. A tick may deposit from a few hundred to more than 5,000 eggs, and when egg laying is completed the mother tick, having fulfilled her purpose, dies in a few days.

After the eggs have been laid they must undergo a period of incubation before they are ready to hatch. The period may be as short as 19 days in the summer, or as long as 200 days if the fall and winter seasons are involved. When incubation has been completed there issues from each egg a small, oval, six-legged larva or seed tick, at first amber-colored, later changing to a rich brown. After crawling slowly over and about the shell from which it has emerged, it usually remains more or less quiet for several days, after which it shows great activity, especially if the weather is warm, and ascends the nearest vegetation, such as grass, herbs, and even shrubs.

Since each female lays an enormous mass of eggs at one spot, thousands of larvæ may appear in the course of time at the same place. The young ticks will ascend the near-by vegetation and collect on the leaves and other parts of plants. This instinct of the seed ticks to climb upward is a very important adaptation to increase their chances of reaching a host. If the vegetation on which they rest is disturbed they become very active and extend their long front legs upward in a divergent position, waving them violently in an attempt to seize hold of a host.

During its life on the pasture the seed tick takes no food and consequently does not increase in size, and unless it reaches a host on

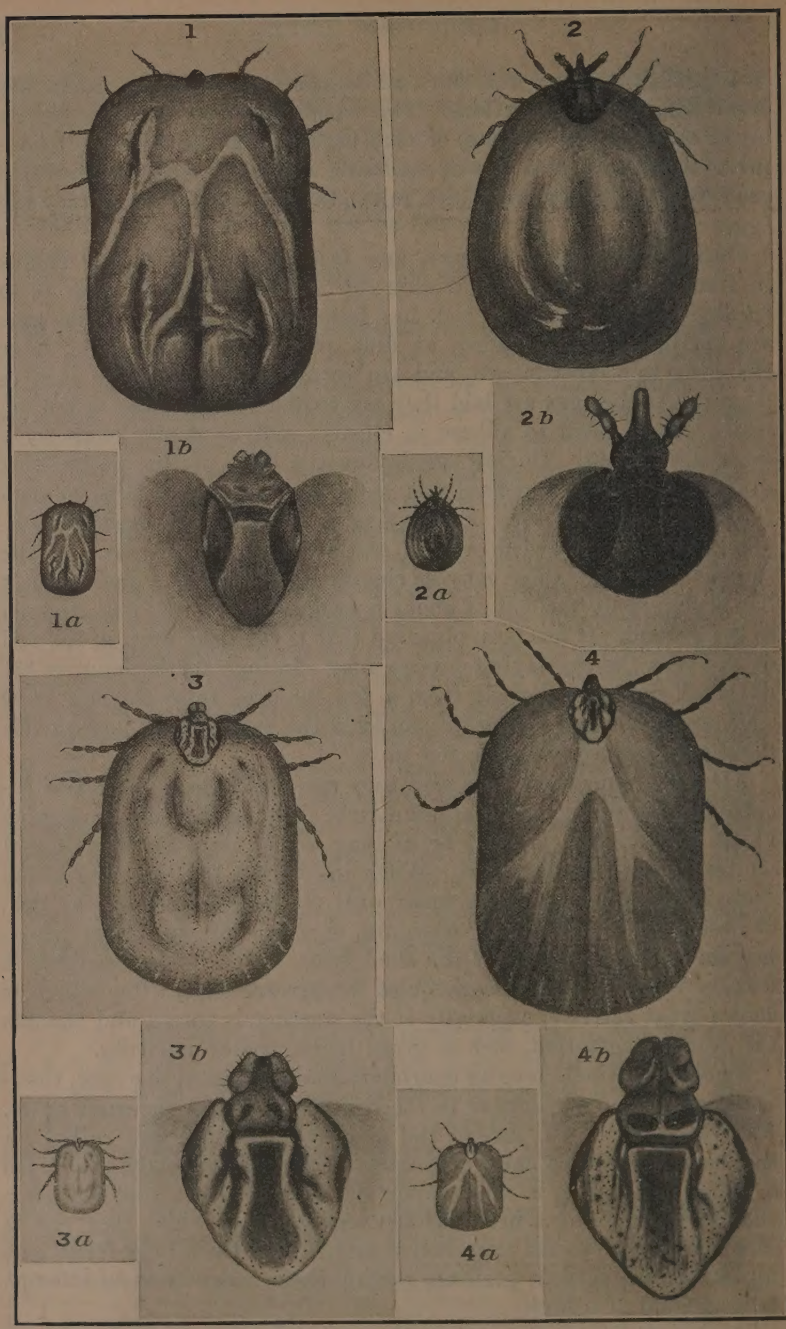

FIG. 2.—Various ticks that infest cattle. 1. Mature female cattle tick, enlarged; 1*a*, same, natural size; 1*b*, head and shield of same, magnified 15 times. 2, Mature female castor-bean tick, enlarged; 2*a*, same, natural size; 2*b*, head and shield of same, magnified 15 times. 3. Mature female net tick, enlarged; 3*a*, same, natural size; 3*b*, head and shield of same, magnified 15 times. 4. Mature female dog or wood tick, enlarged; 4*a*, same, natural size; 4*b*, head and shield of same, magnified 15 times.

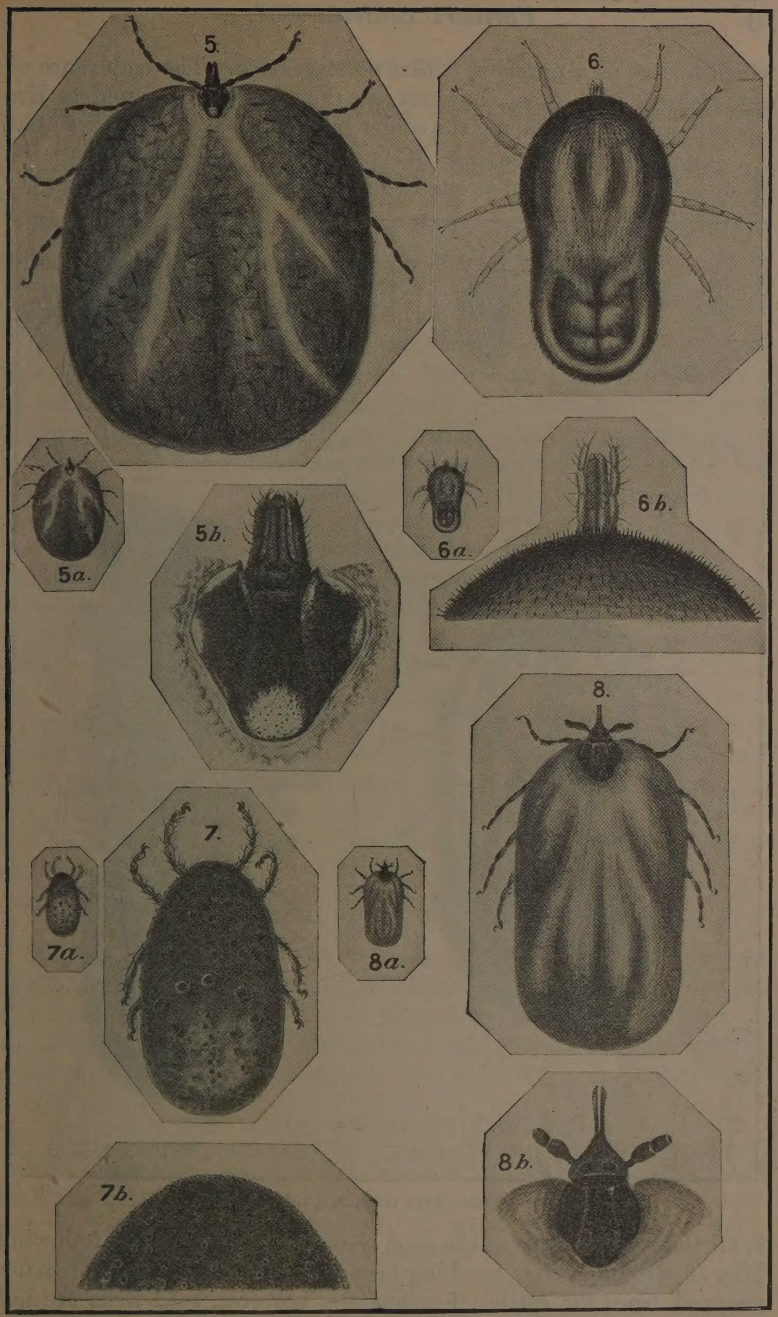

FIG. 3.—Various ticks that infest cattle. 5. Mature female Lone Star tick, enlarged; 5*a*, same, natural size; 5*b*, head and shield of same, magnified 15 times. 6. Mature female ear tick, enlarged; 6*a*, same, natural size; 6*b*, head of same protruding from beneath, magnified 15 times. 7. Mature female chicken tick, enlarged; 7*a*, same, natural size; 7*b*, upper portion of same, head invisible, magnified 10 times. 8. Mature female European dog tick, enlarged; 8*a*, same, natural size; 8*b*, head and shield of same, magnified 15 times.

which to live as a parasite, it dies of starvation. The endurance of seed ticks is very great, however, as they have been found to live more than 8 months during the colder part of the year. For example, it is known that in the case of female ticks that dropped to the ground August 14 and deposited eggs that began to hatch September

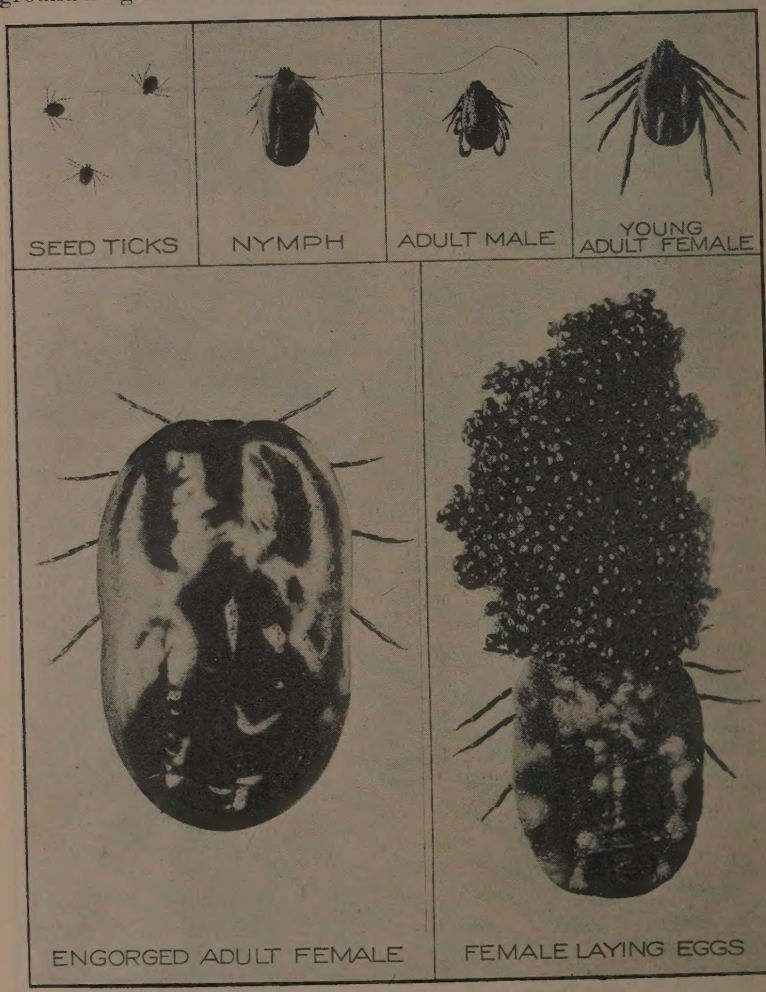

FIG. 4.—Texas-fever ticks, magnified 5 times.

9, all the seed ticks from the eggs were not dead until the following May 13, 246 days after hatching began, or 274 days after the females dropped from the cattle. Fortunately, however, seed ticks are not able to live nearly so long during warm weather and die within a few months in the summer.

DEVELOPMENT ON CATTLE.

The parasitic part of a tick's life begins when the larva or seed tick reaches a favorable host, such as a cow. The tick crawls up over the hair and commonly attaches itself to the skin of the escutcheon, the inside of the thighs and flanks, or to the dewlap. It begins at once to draw blood and soon increases in size. In a few days the young tick changes from a brown color to white, and in from 5 to 12 days molts or sheds its skin. The new form has 8 legs instead of 6 and is known as a nymph.

In from 5 to 11 days after the first molt the tick again sheds its skin and becomes sexually mature. At this stage for the first time, males and females can be distinguished with certainty. The male emerges from his skin as a brown, oval tick, about one-tenth of an inch long. He has reached his growth and goes through no further development, but later he shows great activity, moving about over the skin of the host. The female at the time of molting is slightly larger than the male. She never shows much activity, seldom moving far from her original point of attachment. She still has to undergo most of her growth. After mating, the female increases very rapidly in size and has been known to become fully engorged as early as 48 hours after the second molt, but usually at least 4 days are required for her engorgement. Commonly this period lasts from about a week to as long as 25 days. In exceptional cases, the time that elapses between the attachment of the tick as a seed tick and its dropping from the animal as a fully engorged female may be less than 20 days, but generally it is 3 weeks or a little more. The greatest length of time that a tick has been observed to stay on an animal is 66 days.

SUMMARY OF LIFE HISTORY.

To sum up, on the pasture there are three stages of the tick—the engorged female, the egg, and the larva or seed tick; and on the host animal are also three stages—the larva or seed tick, the nymph, the sexually mature adult of both sexes, and in addition the engorged condition of the female.

METHODS OF ERADICATION.

In undertaking measures for eradicating the tick it is evident that the pest may be attacked in two locations, namely, the pasture and the cattle. Animals may be freed of ticks in two ways. They may be treated with a disinfectant that will destroy all the ticks present, or they may be pastured at proper intervals on tick-free fields until all the ticks have dropped. The method of freeing cattle from ticks by applying a solution that kills the ticks is the

method generally used. The pasture-rotation method is not only more complicated but the necessary tick-free fields are seldom available.

In freeing pastures the method followed may be either direct or indirect. The direct method consists in excluding all cattle, horses, and mules from pastures until all the ticks have died from starvation. This plan is seldom followed because the owner is usually not willing to give up the use of his pasture even temporarily. The indirect plan consists in permitting the cattle and other animals to continue on the infested pasture and treating them at regular intervals with agents destructive to ticks, thus preventing engorged females from dropping and reinfesting the pasture. All the seed ticks on the pasture, or those which hatch from eggs laid by females already there, will die eventually. Those that get on the cattle from time to time will be destroyed by the treatment, while those which fail to find a host will starve to death in the pasture.

DIPPING.

Ticks upon cattle may be destroyed by using a tick-destroying agent, such as arsenic. The dipping vat is the best and cheapest means of applying the remedy. The great advantage of dipping over spraying and applying remedies by hand lies in the fact that thoroughness of the treatment is practically assured.

PROCEDURE IN DIPPING.

When eradication is undertaken, all the cattle, and also the horses and mules if they harbor ticks, are treated regularly every two weeks during the part of the year that the temperature is favorable to treatment, until the ticks have disappeared. The purpose of the treatment is to destroy all ticks that get on the animals before they have had a chance to mature and drop, thus preventing them from reinfesting the pasture, farm, or range. If the treatment used were absolutely effective in destroying each and every tick on the animals treated there would be no renewal of the infestation after the treatment is begun. The cattle would act simply as collectors of ticks which would be destroyed regularly by the treatment applied every two weeks. It is probable, however, that in most instances, either because of the lack of efficiency of the dip or imperfect application, or because of failure to dip all cattle systematically, some ticks escape treatment and reproduce, thus prolonging the time that otherwise would be required for eradication.

If ticks apparently disappear from the cattle after they have been under treatment for some time, the dipping should not be discontinued until a number of careful inspections show that the cattle are

free of ticks. If ticks continue on cattle until cold weather and then finally disappear it should be borne in mind that in all probability eradication has not been accomplished and that there may be engorged females, unhatched eggs, and inactive seed ticks on the farm or range, and that even if the cattle should remain free of ticks during the winter they may become reinfested the following spring. In any case in which ticks disappear from the cattle and treatment is discontinued, the cattle should be watched very carefully for ticks until ample time has elapsed to leave no doubt that eradication has been accomplished.

As a general rule it has been found that if dipping is begun in March and systematically and thoroughly done, all cattle being dipped every 14 days until November, complete eradication will be secured. In dipping, each animal should be completely covered by the dip. To prevent any animals from going through the vat without becoming wet all over, a man, provided with a forked stick, should be stationed at the middle of the vat to shove under those that have not been completely submerged.

Dipping is the only really satisfactory method of treating animals for ticks. In cases of emergency, however, or where there are not cattle enough within a radius of several miles to warrant the construction of a vat in which all the cattle of the community may be dipped, spraying may be advisable. In spraying animals the work should be done with great thoroughness and every portion of the body treated. An animal can not be sprayed properly unless it is tied or otherwise held, nor can good results be obtained unless the hair and skin are thoroughly wetted.

RULE FOR CALCULATING THE CAPACITY OF A VAT.

The capacity of the vat is obtained usually in the following manner: Multiply the average length by the average width in inches, then multiply the product by the depth; this will give the approximate number of cubic inches of space to be filled with dip. Divide this by 231 (the number of cubic inches in a gallon), and the result will be the number of gallons of dip required to charge the vat.

To obtain the average length, add the length at the bottom to the length at the top (that is, at the line to which the vat is to be filled), and divide the sum by 2. Obtain the average width in the same manner. The depth should be taken at the center of the vat, and should be from bottom to dip line only and not to the top of the vat. Likewise, in determining the length and width, measure only the space to be filled with liquid and not above that line. Gauges or rods should be prepared and marked to show the number of gallons at various depths in the vat.

SPECIFICATIONS FOR THE CONSTRUCTION OF A CONCRETE VAT.

Site.—The site selected for the vat should be dry and of sufficient size to permit the construction of the chute, the dripping pen, and at least two additional pens—one for holding the cattle prior to dipping and the other for retaining them, after dipping, until sufficiently dried.

Excavation.—The excavation should be made 1 foot wider and 1 foot longer than the inside dimensions of the vat and should conform to its shape. The inside dimensions of the vat are shown on the drawings (figure 5) and are as follows: Length at top of vat, 26 feet; bottom, 12 feet; width at top, 3 feet; at bottom, 1½ feet; depth, 7 feet.

The sides and bottoms of the excavation should be firm and solid, as they are to serve for the outside forms in casting the concrete. If it is necessary to do any filling in order to conform to the shape of the vat, the filling should be puddled and thoroughly rammed until solid. The stability of the concrete depends on the foundation.

Forms and fences.—The wooden forms should be constructed of 1-inch boards and 2 by 4 inch braces, the boards being nailed to the outside face of the braces, as shown in the drawings. The sides and end walls should be built 8 inches higher than the surface of the ground, which should be level. Any suitable lumber may be used for the forms and fences. Saplings may be used for posts.

Concrete.—The concrete should be made of (by measure) 1 part of cement, 2½ parts of sand, and 5 of broken rock or gravel. The cement should be of standard brand of Portland, the sand clean and coarse, and the broken rock from about ¼-inch pieces to those not larger than will pass in every direction through a 1-inch ring. A vat according to the plan (figure 5) will require about 40 sacks of cement, 5 yards of sand, and 10 yards of gravel.

A 26-foot vat is used extensively for eradication purposes with satisfactory results. If it is desired, however, to lengthen the body of the vat on account of large numbers of cattle to be treated, the following quantities of concrete material should be added for each lineal or running foot—cement, 1½ sacks; sand, 0.12 yard; stone, 0.24 yard.

The sand is measured out first and the cement emptied on top, and the two materials thoroughly mixed, dry. In the meantime the stone may be measured out and thoroughly drenched with water. The cement-sand mixture is mixed with water and the resulting mortar then combined with the stone. The stone should be shoveled on the mortar, previously spread out in a thin layer. Mixing should continue until the stone is thoroughly coated with mortar, more water being added during the mixing process if necessary.

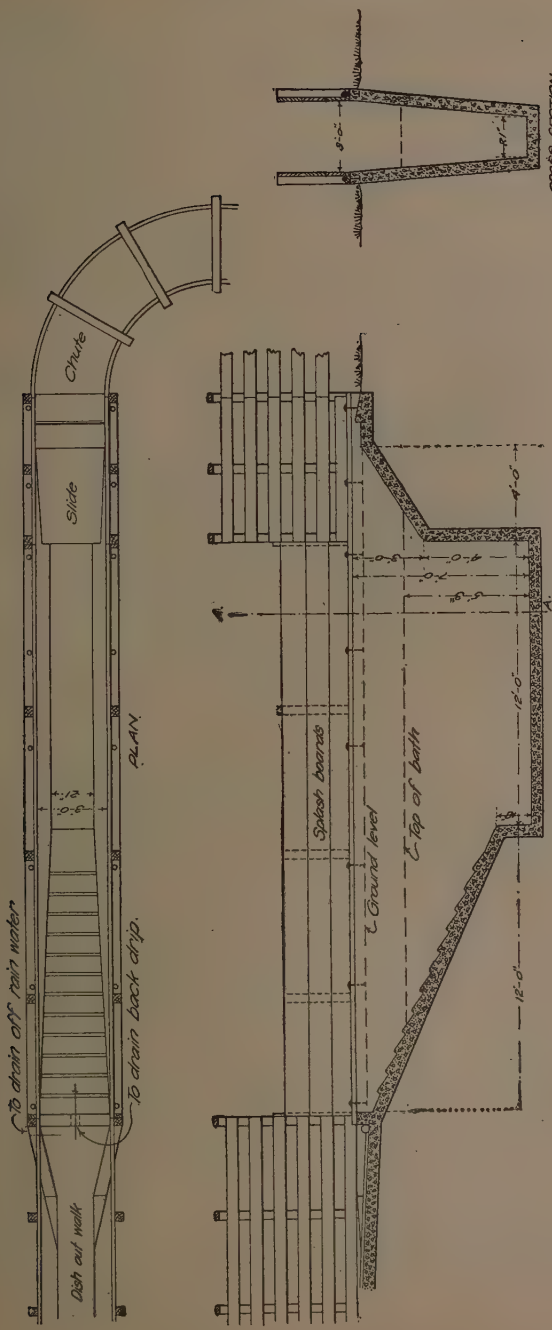

FIG. 5.—Plan for construction of concrete vat.

Laying.—Before laying the concrete the molds should be set and thoroughly braced into place. The side forms may be suspended in the excavation with their lower edges 6 inches from the bottom. They are held in place by crosspieces nailed to the uprights and of sufficient length to rest on supports placed several feet from the edges of the excavation. The concrete for the bottom and incline is deposited first, the mixture being of a consistence that water will flush to the surface on ramming. The mixtures for the sides and end should be very wet and thoroughly puddled into place. The consistence of the concrete for the side walls should be such that it will run off the shovel unless handled quickly.

The laying of the concrete should be done, if possible, in one operation, so there will be no joints between new and old work. If it becomes necessary to do the concrete work on two or more days the surface to receive the new concrete should be washed clean and coated with a grout of pure Portland cement and water mixed to the consistence of cream. The new concrete should be placed before the grout has set. Extreme care must be taken to prevent dirt from falling on top of the fresh concrete.

The forms should not be removed until the concrete is set, which in moderate weather takes place in about 24 hours. Wet down the concrete about twice in 24 hours until the forms are removed. In damp, cold weather at least 48 hours should be allowed before removing the forms. It is advisable, especially in water-soaked ground, to allow the forms to remain in place for one week before removal.

Surfacing or finishing coat.—Dampen the walls before applying the finishing coat. Cover the entire inside surface of walls and floor with a coating of cement and sand, mixed half-and-half, and with water enough to make it "quaky." Place a small quantity of the mixture on a float; beginning at the bottom of the wall as near the floor as possible, make one stroke upward; take up another float of the cement-sand mixture, overlap the ending of the last float and make another upward stroke. Repeat until walls are completed. Do not try to float the walls too smooth. Finish with cement and water mixed to thickness of cream and applied with a kalsomine or whitewash brush.

Exit incline.—The exit incline, as shown in the plans (figure 5), is not so steep as to require a cleated false bottom. The surface, however, should be finished very roughly to permit the animals to maintain a secure foothold.

Slide.—The slide for dry or range cattle may be built only 2 feet long with a drop of 2 feet. For dairy cows, however, it is advisable to have a slide 4 feet long, that is, long enough for the cow to stand

on, with a drop of 2½ or 3 feet so that the arsenical bath will cover the edge of the slide at least a foot in depth. This kind of slide for dairy cows prevents bruising the udders.

Slides should be finished very smooth by much floating of the concrete and finishing with a mixture of equal parts of cement and fine sand.

Cover.—The vat should be so inclosed or covered as to keep children or small animals from entering or falling in.

Dripping chute and chute leading to the vat.—The dripping chute, which is regarded as more satisfactory than a dripping pen, is built at the head of the exit incline in line with the vat. It should be about 30 inches wide. The length will depend on the number of cattle to be accommodated at one time. From 4 to 5 feet are allowed for each animal, and a length of from 20 to 40 feet is considered a convenient size for small herds. The floor should be made of concrete, at least 18 inches wide, sloping toward the vat so that the dripping from the cattle will flow back into the vat through the opening provided. The floor at the sides of the chute is raised about 2 inches in the form of a curb to keep the dip from running off.

The chute leading to the vat should be not more than 30 inches wide and 20 feet long and it is desirable to have the receiving pen and retaining chute large enough to accommodate the animals to be dipped.

PASTURE ROTATION.

TIME REQUIRED TO KILL TICKS BY STARVATION.

The time necessary for ticks to die out on a pasture after removal of the cattle is of importance with reference not only to methods of eradication by rotation but to methods of eradication by dipping. When systematic dipping is begun and further infection of the pasture is stopped by killing all ticks that get on the cattle, the period during which the dipping must be continued in order to secure eradication is primarily dependent upon the length of life of the seed ticks already on the pasture and of those that hatch out from eggs laid by ticks that dropped before dipping was begun.

The time required for the ticks to die out after all animals have been removed from infested fields and pastures varies considerably, depending principally on the climate and the weather. The dates when pastures will be free of ticks after all cattle have been removed are given in the following table:

TABLE 1.—*Time required to free pastures from ticks by starvation.*

BASED ON DATA OBTAINED AT DALLAS, TEX., AND AUBURN, ALA.

Date of removal of all animals from pasture.	Date when pasture will be free from ticks.	Date of removal of all animals from pasture.	Date when pasture will be free from ticks.
July 1	Mar. 1	Dec. 15 to Mar. 15, inclusive	Sept. 1
Aug. 1	May 1	Apr. 1	Sept. 15
Sept. 1	July 1	Apr. 15	Oct. 15
Oct. 1 to Nov. 1, inclusive	Aug. 1	May 1 to June 15, inclusive	Nov. 1
Dec. 1	Aug. 15		

BASED ON DATA OBTAINED AT KNOXVILLE, TENN.

Jan. 1	Aug. 1	June 15	May 1
Feb. 1 to Mar. 15	Nov. 15	July 1	June 15
Apr. 1 to 15	Jan. 1	July 15	July 1
May 1	Jan. 15	Aug. 1 to 15	July 15
May 15 to June 1	Feb. 15	Sept. 1 to Oct. 1	Sept. 15

The first part of the table is based on investigations by Hunter and Hooker[1] at Dallas, Tex., and by Graybill at Auburn, Ala., under cooperation between the Bureau of Animal Industry and the veterinary department of the Alabama Polytechnic Institute.[2] All the periods obtained by Newell and Dougherty (1906)[3] in work carried on at Baton Rouge, La., which is much further south, are shorter. The periods given in the table should be found ample for all places no further north than Dallas, Tex., or Auburn, Ala.

In general, moisture and cold prolong, while dryness and heat shorten, the duration of the period that ticks will live on a pasture. If some portions of the same pasture differ with regard to temperature and moisture, as frequently happens, some parts become free of ticks before others do. Other things being equal, high, dry, unshaded land becomes tick-free sooner than low, damp, shady land. Land, however, that is excessively moist and extremely shady, as along some river bottoms, is not likely to be a favorable breeding place for the cattle ticks, and lowlands subject to more or less regular overflows, as a rule are only lightly infested, if at all.

The time required for freeing pastures in the southern part of the infested area may be considerably less in many localities than that indicated in the first part of Table 1, yet the safest plan is to follow the table in most localities in the South. There is little doubt that in most regions in the northern half of the infested area the periods

[1] Bulletin 72, Bureau of Entomology, U. S. Department of Agriculture.
[2] Bulletin 130, Bureau of Animal Industry, U. S. Department of Agriculture.
[3] Circular 10, State Crop Pest Commission of Louisiana.

are longer. Cotton[1] obtained at Knoxville, Tenn., during the years from 1907 to 1909, inclusive, the periods given in the lower part of Table 1.

According to the experiments conducted by Cotton, the normal duration of an infestation may be considerably shortened or even suddenly brought to an end in infested pastures and fields by the occurrence of exceptionally cold weather. He found that a certain per cent of engorged females are destroyed by a temperature of 23° F., that all engorged females are destroyed by a temperature of 14° F. when not provided with a protective covering, and that ticks provided with a covering of dry chaff were able to survive a temperature of 12° F., but if the covering is wet they are killed as readily as when unprotected. It was found also that ticks that have deposited some eggs are much more readily destroyed than those that have not done so. In addition it was demonstrated that all unprotected eggs and all seed ticks are destroyed at temperatures of 4° F. and 2° F., respectively, but that eggs protected by dry litter can endure a much colder temperature. It is thus seen that the infestation of fields may be greatly reduced during cold spells and, if the temperature falls to about zero, may be entirely destroyed. In case the temperature falls only to a point at which all the females are destroyed, the only result accomplished will be a shortening of the period of infestation.

It would be well for stock owners, in eradicating ticks, to take advantage, so far as practicable, of all zero weather. It should be remembered, however, that cattle even during the coldest weather are likely to harbor ticks which will be unaffected by the low temperature. The ticks when they drop will reinfest the place; consequently, when a spell of zero weather occurs, if the cattle are not on the fields, pastures, or ranges they should not be returned to them until freed of ticks. If on pasture they should be removed at once and not returned until made free of ticks by one of the methods suggested in this bulletin.

TIME REQUIRED TO FREE CATTLE OF TICKS ON UNINFESTED FIELDS.

Although the method is not often used, it is nevertheless possible to free cattle of ticks by placing them on a series of uninfested fields. This plan is based on the fact that the female tick must drop from the host to the ground before eggs can be laid and before young ticks will develop.

The shortest time in which seed ticks appear after engorged females have been dropped is 20 days. Consequently, cattle placed on a tick-free field during the warmer part of the year are not in danger of

[1] Bulletin 94, Agricultural Experiment Station of the University of Tennessee.

becoming infested again with young ticks until 20 days have elapsed. The time required for all the ticks to drop after cattle have been placed on uninfested land varies with the temperature, being much longer in winter than in summer. Beginning at various times of the year, the time required is given in Table 2.

TABLE 2.—*Time required for all ticks to drop from cattle placed on tick-free land.*

When ticky cattle are placed on tick-free land during—	All ticks will have dropped in—	When ticky cattle are placed on tick-free land during—	All ticks will have dropped in—
August	Six weeks.	March	Seven weeks.
September	Do.	April	Six weeks.
October	Eight weeks.	May	Do.
November	Nine weeks.	June	Do.
January	Ten weeks.	July	Five weeks.
February	Seven weeks.		

Freeing cattle of ticks by rotation on tick-free land.—The plan of freeing cattle of ticks by changing them from one lot or field to another is as follows: Beginning at any time of the year from March to September, inclusive, in the southern half of the infested area, the cattle are removed from the tick-infested pasture they have been occupying to a tick-free lot or field and left there for not more than 20 days. During that time a considerable number of ticks will drop. In order to prevent the cattle from becoming reinfested (by seed ticks resulting from eggs laid by females that have dropped), the herd is then changed to a second tick-free inclosure for 20 days longer, and if they are not free of ticks by that time, they are placed in a third tick-free inclosure for 20 days more. Should the two changes at intervals of 20 days have been made, 60 days will have elapsed, which, during the time of year indicated, is ample time for all ticks to have dropped, and the animals are ready to be placed on a tick-free pasture or field without danger of becoming reinfested. The periods to free cattle (given in the table above) are believed to be ample. It is a wise precaution, however, to examine the cattle carefully for ticks before placing them in the uninfested field they are to occupy.

From October to February, inclusive, the time required for seed ticks to appear after females have dropped is much longer than the time necessary for all the ticks to drop from cattle. Consequently, if it is desired, the herd may be left on the same field for the required length of time without danger of reinfestation.

Table 3 gives the approximate dates when ticky cattle are in danger of reinfestation when placed on tick-free land at various times of the year. The first section applies to most localities in the southern half of the infested region, and the second section to localities having temperature conditions about the same as Knoxville, Tenn.

TABLE 8.—*Date on which seed ticks will appear after ticky cattle have been placed on tick-free land.*

BASED ON DATA OBTAINED AT BATON ROUGE, LA., AUBURN, ALA., AND DALLAS, TEX.

Date cattle placed on tick-free pastures.	Date seed ticks will appear.
Jan. 1 to Feb. 4, inclusive	Apr. 24
Mar. 3	May 3
Apr. 15	May 20
May 1	June 5
June 5	June 28
July 1	July 25
Aug. 5	Aug. 30
Sept. 1	Oct. 7
Oct. 1	Feb. 25
Nov. 1 to Dec. 15, inclusive	Mar. 3

BASED ON DATA OBTAINED AT KNOXVILLE, TENN.

Jan. 11 to Mar. 4, inclusive	May 29
Apr. 1	June 3
May 15	June 20
June 12	July 19
July 3	Aug. 2
Aug. 6	Sept. 6
Sept. 4	Apr. 14
Oct. 2	May 20

ARSENICAL DIPS.

PROPERTIES OF SUBSTANCES USED IN MAKING ARSENICAL DIPS.

The successful preparation of an arsenical dip calls for some knowledge of the properties of the raw materials.

WHITE ARSENIC.

White arsenic (*arsenic trioxid*, *arsenious* or *arsenous oxid* or *acid*) must be purchased in the form of a fine powder and under a guaranty of 98 or 99 per cent purity. Water, even when boiling, dissolves it only slowly, but by the use of certain other chemicals it may readily and abundantly be brought into solution.

One must never forget that white arsenic is a violent poison to man and animals. So are the concentrated dips prepared from it. The precautions necessary for safety will be discussed under a separate section, and any person who has anything whatever to do with arsenical dips is advised to read it often enough to keep the points fresh in mind.

CAUSTIC SODA.

Caustic soda (*sodium hydroxid*), on account of its wide range of application by chemists, pharmacists, and manufacturing industries, occurs commercially in a number of different forms, as powder, sticks, solid masses, or broken fragments; in color it ranges from pure white to grayish or brownish tints. For the use of chemists and pharmacists it is put up in glass bottles; for industrial purposes it is supplied in various-sized cans or drums of thin sheet iron. The latter is the variety that should be purchased for making dip. The

5 or 10-pound can is the best size to buy for home use; larger consumers probably can handle the material in larger drums conveniently and of course more economically. The purchaser must make sure that the contents of the drum he contemplates buying are in fragmentary form, for some caustic soda is run into drums in a melted condition and on cooling forms a single solid cake, which is not adapted for the present purpose. It always should be purchased under a guaranty of not less than 85 per cent actual caustic soda.

Caustic soda is an intensely active and powerful substance. When exposed to the air it strongly attracts moisture, increasing in weight and becoming pasty, while at the same time it becomes contaminated with sodium carbonate through absorption of carbon dioxid. Hence it always must be purchased in original containers, never in bulk; the container must not be opened until just before the material is to be used; the substance must not be allowed to stand exposed to the air, and if any is left over which is to be kept for subsequent use it must be immediately transferred to a tin pail provided with a tight-fitting cover.

Owing to the intense chemical activity of caustic soda it is extremely corrosive in its effect upon skin or clothes, and upon the lungs if its dust is inhaled. Therefore it is necessary to handle it gently to avoid the raising of dust and to wash off at once with water any which may touch the skin or clothing.

LYE.

Lye designates a grade of caustic soda put up primarily for domestic use, such as making soap from waste grease and for general cleansing. It is sometimes of very inferior quality. If a guaranty regarding its purity can be obtained, it may be used for dip making, in case of necessity, in the same proportions as caustic soda.

SODIUM CARBONATE.

Sodium carbonate is sold in a number of forms which differ greatly in strength, that is, in the proportion of actual sodium carbonate they contain. Consequently the cheapest in cost per pound may not be the most economical to use. *Soda ash* is the strongest, but is not recommended for the home preparation of dips. It is of uncertain strength when purchased and becomes weaker on exposure to air, while in contact with water it lumps badly and dissolves slowly. *Sal soda* is the weakest and probably the least economical form, but because it is so well known and so easily obtained it has been the most generally used form of sodium carbonate for homemade dips. Its relative weakness is due to the fact that almost two-thirds of it is water, combined as "water of crystallization." When fresh it consists of large, nearly transparent crystals, but on exposure to air it tends to fall to a white powder. This change is simply due to the evaporation of the water of crystallization, and consequently the

material becomes stronger, almost approaching *monohydrated sodium carbonate*. This latter substance is a coarse, granular powder, containing only about one-seventh of its weight of water of crystallization, and is very little affected by exposure to air. *Sesquicarbonate of soda* is still another form which is stronger than sal soda, containing less than one-third of its weight of substances not actual sodium carbonate. It is likewise little affected by air.

Both monohydrated carbonate and sesquicarbonate dissolve readily and can replace sal soda to excellent advantage provided their composition is guaranteed by a reliable firm. In calculating formulas and costs it may be assumed that 10 pounds of sal soda can be replaced by 4¼ pounds of the monohydrate or 5 pounds of the sesquicarbonate.

PINE TAR.

Pine tar when fresh is semiliquid, but with age becomes granular and nearly solid, in which condition it is of less value. Mixed with it is usually more or less water of decidedly acid properties (pyroligneous acid), which on standing tends to float on the surface and should be dipped or poured off before the tar is used.

Tar is heavier than water and when stirred with it usually forms a very poor mixture from which most of the tar rapidly settles out, but when the water is of just the right temperature and somewhat alkaline a fairly stable suspension generally may be obtained. When previously treated with caustic soda sufficient to combine with a considerable proportion of the tar acids, or when blended with soap, the tar easily mixes with water and then forms a good and permanent emulsion.

THE GENERAL COMPOSITION OF DIPS.

All arsenical cattle dips contain arsenious oxid as the active tick-killing agent. But since straight arsenious oxid—that is, white arsenic—is so slowly soluble in water, some chemical agent such as sodium carbonate or hydroxid is necessary to bring it into solution. In this way the white arsenic is changed to sodium arsenite. If certain manufacturing difficulties can be overcome it is possible that sodium arsenite of reliable composition may appear later on the market. Such a material could be dissolved directly in water and the trouble of making the compound from white arsenic and caustic soda would be avoided.

But a plain water solution of sodium arsenite, however obtained, does not make an entirely satisfactory dip. Better results follow when pine tar is added. Possibly the pine tar increases the wetting or spreading power of the bath, which naturally results in better penetration and effectiveness against ticks and less risk of blistering cattle. It is probable that the pine tar also makes the sodium arsenite adhere better, so that it will less readily wash off in rain, or dust off in dry weather. Perhaps it is distasteful to seed ticks so that they

are less liable to attach to cattle after dipping. Probably, too, cattle will be less inclined to drink the bath while going through the vat.

Proprietary arsenical cattle dips appear now to have passed the experimental stage and to have become established as reliable and useful products. At any rate this can be said of the brands which have received permission for use in official dipping in place of the homemade dip. The formulas and standard samples of all such brands are in possession of the Bureau of Animal Industry and the manufacturers are required to guarantee that their products as placed on the market will be kept up to standard and that all requirements of the bureau will be observed. Like the homemade dip they all contain sodium arsenite as the active tick-killing agent. They do not all contain pine tar, because that substance is difficult to blend into a highly concentrated product, but they all contain some other substance or mixture of substances of such character and in such quantity as field trials have proved will produce the same effects.

They are not regarded as any more effective or any milder on the cattle than properly prepared homemade dips. None the less they are undoubtedly safer for general use because they offer decidedly fewer opportunities for making mistakes in the quantities used or in the operations gone through and also fewer chances for accidental poisoning or other injury from the handling of powerful chemicals. Whether their higher cost is sufficiently outweighed by these considerations is necessarily a matter for individual decision.

MAKING THE S-B DIP.[1]

Homemade dips usually are made after the "S-B" formula. This calls for two stock solutions, arsenic stock and tar stock, which must not be mixed except in the diluted dipping bath.

[1] Abbreviated from "self-boiled," because sufficient heat to prepare the dip is generated by chemical action between the raw materials. The field men of the bureau do not agree on the best method of mixing. The truth is that several modifications give good results in the hands of experienced men and each man naturally prefers the one with which he is most familiar. The method of mixing here given is the original method published in Farmers' Bulletin 603, and, all things considered, appears to be somewhat the safest to recommend for general use, particularly to those who must depend entirely on printed instructions. But a modification devised by Dr. Harry Grafke, of the Bureau of Animal Industry, may be of interest. He says: "In a 5-gallon kettle or metal pail place the 10 pounds white arsenic, then add one-half gallon of cold water in small quantities at a time, and stir with a broad paddle until all the arsenic is wet. Place the 4 pounds of caustic soda in a gallon pail, add one-half gallon of water, and stir until the caustic soda is practically all dissolved. Lean the top end of the broad paddle against the top of the kettle containing the arsenic and without delay begin adding the caustic-soda solution in small portions, allowing it to run down the surface of the broad paddle into the arsenic in such a way as to avoid splashing. If the solution begins to boil considerably stop adding the caustic-soda solution for a moment. Occasionally stir the mixture while the caustic-soda solution is being added, after which continue to stir until all the arsenic is dissolved. Without allowing the liquid to cool, add the sal soda and stir for a few moments, then add 1 gallon of water and continue to stir until the sal soda is completely dissolved." According to Dr. Grafke, this method is preferred by a considerable number of experienced men.

Arsenic stock requires the following materials ready to hand before starting:

	Pounds.
Caustic soda	4
White arsenic	10
Sal-soda crystals	10

There should be also some means for heating the solution in case, as sometimes happens because of impure materials, lack of skill, or some unforeseen circumstance, the heat created by mixing the materials should be insufficient to dissolve all the arsenic.

In a 5-gallon kettle or metal[1] pail place the 4 pounds of caustic soda, add 1 gallon of cold water, and stir with a stick until the caustic soda is practically all dissolved. Without delay begin adding the white arsenic, in portions of a pound or two at a time, as fast as it can be dissolved without causing the solution to boil, stirring all the time. If the liquid begins to boil, stop stirring and let it cool slightly before adding more arsenic. The secret of success is to work the arsenic in fast enough to keep the solution very hot—nearly but not quite at the boiling point. The result should be a clear solution, except for dirt. If the liquid persistently remains muddy or milky, it may be because the operation has been conducted so fast that much water has been boiled out and sodium arsenite is beginning to crystallize, so add another gallon of water and stir. If the solution does not then clear up, the caustic soda must have been very low grade, and the undissolved substance must be arsenic. In that case, put the kettle over the fire, heat nearly, but not quite, to boiling, and stir. As soon as the solution of arsenic is complete, dilute to about 4 gallons, add the sodium carbonate, and stir until dissolved.

Cautions: It is necessary to avoid splashing. Hence never work hurriedly; stir deliberately and regularly; do not dump in the arsenic and sal soda, but carefully slide them in from a grocer's scoop held close to the side of the pail and to the surface of the liquid. Perform the whole operation in a well-ventilated place and avoid inhaling steam.

After the solution has become cold add water to make it to exactly 5 gallons,[2] mix well, let settle, and draw off into containers which can be tightly corked or otherwise closed. Jugs or demijohns are best, but tin cans will serve if occasionally inspected for leaks which may occur after a time through the action of the solution upon the solder of the can.

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[1] The chemicals employed have no effect upon iron. They will, however, actively corrode zinc, tin, or solder; hence a soldered pail must be watched for leaks and is far inferior to a seamless pail, stamped from a single sheet of iron. A tinned pail is preferred to a galvanized one, but a plain iron seamless pail or an iron kettle should be obtained if possible.

[2] Best done by previously determining by measurement the depth of 5 gallons of water in the kettle. Set the kettle exactly level and mark the depth on a stick held vertically on the center of the bottom.

Tar stock is prepared thus:

In a large metal pail dissolve three-fourths of a pound of caustic soda in 1 quart of water, add 1 gallon of pine tar, and stir thoroughly with a wooden paddle until the mixture, which at first looks streaked and muddy, brightens to a uniform, thick fluid somewhat resembling molasses. Test it by letting about a teaspoonful drip from the paddle into a glass of water (a glass fruit jar or a wide-mouth bottle will do) and stirring thoroughly with a sliver of wood. It should mix perfectly with the water. Globules of tar which can be seen by looking at the glass from underneath and which can not be blended with the water by repeated stirring indicate that more caustic-soda solution is needed. In that case make up more caustic-soda solution of the same strength and add it, not more than a pint at a time, with thorough stirring, until the desired effect is produced.

If an appropriate glass vessel for making the test is not at hand, take a little of the mixture between the fingers, then dip the fingers under water and try to rub off the tar. It should leave the fingers perfectly clean after a little rubbing with water. If an oily coating remains, more caustic-soda solution is needed. Such an extra addition of caustic soda will be required only in case of a very low-grade chemical or a very highly acid tar. The tar stock should be kept in closed containers, such as a pail with a friction top.

The quantity of S–B arsenic stock or of tar stock made in one operation can be varied as desired, provided the above-given proportions of the ingredients are adhered to. But one should attempt to work the S–B formula on a larger scale only after skill and experience have been acquired.

MAKING THE BOILED DIP.

The boiled dip is less convenient than the S–B dip, but the final composition and effect of dipping baths prepared from the two is the same.

To make a 500-gallon bath provide:

Sal-soda crystals	24 pounds.
White arsenic	8 pounds.
Pine tar	1 gallon.

Put 25 gallons of water into a kettle or tank of from 40 to 50 gallons' capacity, heat to boiling, and add the sal soda. When this has dissolved add the white arsenic, then boil and stir for 15 minutes or longer, until the white arsenic has entirely disappeared. If intended for immediate use cool to 140° F. (by addition of cold water if desired), then pour in the pine tar in a thin stream while constantly and vigorously stirring the solution. Immediately empty the liquid into the dipping vat, which has already been three-fourths filled with water, and stir thoroughly.

All the utensils must be free from greasy or oily matter which would coat the arsenic and hinder its solution. The operation of boiling requires constant attention to avoid loss by foaming. Hard water may be used, but in that case considerable undissolved material which, however, does not contain any arsenic, may be left after boiling.

For a stock solution to be kept on hand and used when needed add no tar, but after the solution has become cold make it up to 25 gallons, stir well, let settle, and draw off into containers which can be well closed. In this case the tar stock previously described is also required.

DILUTING THE DIP TO FORM A BATH.

First run water into the vat about three-fourths up to the dipping line, at which its capacity must be known. If tar stock is to be used the necessary amount will be one-third of a gallon for every 100 gallons of vat capacity. Measure it out, mix it with 2 or 3 times its volume of water and pour it along the surface of the water in the vat, stirring a little.

Every 100 gallons of standard-strength[1] bath calls for 1⅜ pounds white arsenic, which quantity is contained in four-fifths of a gallon of S–B stock or in 5 gallons of boiled stock. From these figures the quantity of arsenic or stock needed to charge the vat may be calculated. Or one may base the calculation on the following facts:

One pound of white arsenic will make 62½ gallons of bath.
One gallon of S–B stock will make 125 gallons of bath.
One gallon of boiled arsenic stock will make 20 gallons of bath.

All solutions of arsenic are considerably heavier than water and if carelessly put into the vat they may plunge to the bottom and be difficult to mix. Therefore always pour the arsenic stock or a proprietary dip in a thin stream evenly along the vat except at the shallow exit end. Another precaution to be taken in handling proprietary dips is never to mix them first with small quantities of water, which may "break" them. Pour them directly into the water in the vat.

Finally add water up to the dipping line and stir well. An excellent way to stir is by a pail tied to a rope. Sink it at the entrance end of the vat and haul it along the bottom to the exit. Then

[1] The standard strength here referred to is that employed throughout the area in which cooperative tick eradication is conducted. It is based on the supposition that the cattle will be dipped every two weeks throughout the season and meanwhile will remain under quarantine. If, however, they are to leave the quarantined area special precautions must be taken that they carry no tick infection, and consequently they are subjected to a stronger dip, namely, from 0.22 to 0.24 per cent arsenious oxid. The dipping must be done under supervision of an employee of the Bureau of Animal Industry and in accordance with regulations published in B. A. I. Order 263.

raise it, throw it back to the entrance end, and haul through again, repeating as many times as necessary but always hauling through in the same direction.

The standard-strength bath prepared as above contains practically 0.19 per cent arsenious oxid when fresh. After use oxidation may set in and weaken it, but it will not need to be strengthened so long as it tests not less than 0.175 per cent arsenious oxid.

To make up small quantities for spraying, to each 5 gallons of water measured out add first 2 fluid ounces (4 tablespoonfuls) of tar stock, and then 5½ fluid ounces of S–B stock or 2⅛ pints of boiled arsenic stock.

The standard strength of bath should be adhered to so far as possible because its effectiveness against ticks will effect eradication in the least time and with fewest dippings. But if time is not pressing it is sometimes best to begin with a lower strength, say 0.14 or 0.15 per cent, and gradually work up to full strength as the cattle become accustomed to the treatment. This is certainly a wise method for the individual cattle owner who is outside the area of cooperative work and who lacks aid and advice from experts. Weather conditions also need to be considered. Hot or moist weather is more trying to the cattle than cool or dry weather. The longer the time needed for the cattle to dry off after dipping, which of course primarily depends on the proportion of moisture in the air, the more liable they are to show blistering or other injury through the continued absorption of arsenic by the skin. The combination of heat and moisture is particularly bad and under such conditions it may be desirable, unless other conditions prohibit, to use the bath somewhat weaker than standard strength. The following table shows the quantities of arsenic and stock solutions contained in 100 gallons of bath of different strengths, so that the quantities necessary to charge a vat of any size at any strength can be found by simple multiplication.

TABLE 4.—*Composition of dipping baths.*

Actual arsenious oxid.	Per 100 gallons of bath.			Actual arsenious oxid.	Per 100 gallons of bath.		
	White arsenic.	S–B stock.	Boiled stock.		White arsenic.	S–B stock.	Boiled stock.
Per cent.	*Pounds.*	*Gallons.*	*Gallons.*	*Per cent.*	*Pounds.*	*Gallons.*	*Gallons.*
0.05	0.42	0.21	1.3	0.15	1.25	0.63	3.9
.06	.50	.25	1.6	.16	1.33	.67	4.2
.07	.58	.29	1.8	.17	1.41	.71	4.4
.08	.66	.33	2.1	.18	1.49	.75	4.7
.09	.75	.38	2.3	.19	1.58	.79	4.9
.10	.83	.42	2.6	.20	1.66	.83	.....
.11	.91	.46	2.8	.21	1.74	.87	.....
.12	1.00	.50	3.1	.22	1.83	.92	.....
.13	1.08	.54	3.4	.23	1.91	.96	.....
.14	1.16	.58	3.6	.24	2.00	1.00	.....

REPLENISHING THE BATH AND CORRECTING ITS STRENGTH.

As dipping goes on the bath naturally needs replenishing, and its strength probably needs correction from time to time. The causes which may lead to changes in the strength of arsenical baths, together with methods for making chemical tests, have been discussed elsewhere.[1] Before leaving the vat after dipping one may measure the depth of the bath or mark its level on the side of the vat. But even then at the next dipping one can not be certain just how much a change of level has affected the strength of the bath. For instance some of the bath may have leaked out from the bottom while rain water has run in from the top. Furthermore certain microorganisms can grow in the bath in spite of the presence of the poisonous arsenic, and can greatly affect its strength. As already mentioned, the active ingredient of the bath is sodium arsenite. The microorganisms in the process of growth can transfer oxygen from the air to the sodium arsenite, thus converting it to sodium arsenate, a distinctly different compound of arsenic and much less poisonous to ticks.

The rate at which a bath may lose strength through oxidation depends on conditions and is very variable, but ordinarily is sufficiently rapid to weaken the bath decidedly in a month or two. There is, also, a certain species of microorganism which can grow in baths through which large numbers of cattle are passed frequently and which operates in precisely the opposite manner from those mentioned above, namely, by reducing arsenate to arsenite, thus rendering the bath stronger.

It is therefore plain that the only sure way to get proper results from successive dippings in the same bath is to make a chemical test of its strength shortly before each dipping. The Bureau of Animal Industry provides all officials engaged in cooperative eradication work with outfits for making this test. It is easily carried out by a properly qualified person, and the cattle owner who dips privately should have his baths tested in the same way. If a sample must be sent away for test certain precautions are necessary. First stir the bath well. Fill the bottle (not less than one-fourth pint) nearly to the neck and at once carefully add concentrated formaldehyde[2] (which is cheap and can be obtained from a druggist) with a medicine dropper in the proportion of 5 drops to each one-fourth pint. Cork tightly and send at once.

No anxiety need be felt regarding the accumulation of oxidized arsenic in the bath during a single season's use. Experiments by the Bureau of Animal Industry have shown sodium arsenate to be far

[1] U. S. Department of Agriculture Bulletins 76 and 259.

[2] This is to act as a preservative against microorganisms, which may act much more rapidly in a small sample than in the original bath in its comparatively cool location underground.

less injurious to cattle than sodium arsenite. Field experience, too, indicates that under ordinary conditions, provided the vat has been cleaned out and freshly charged in the spring, danger of injury from this cause need not be considered.

In practice, baths nearly always are both strengthened and replenished in one operation and it is decidedly the simplest and best procedure. First run water in up to the dipping line, at which the capacity is known, and stir thoroughly. Take out a sample and test it to determine the per cent of arsenious oxid. Then find out, by referring to Table 4, how much arsenic or stock, whichever is to be used, is actually contained in 100 gallons of the bath as it stands. Subtract that quantity from the quantity which corresponds to the desired strength of bath, and multiply the remainder by the number of hundreds of gallons of vat capacity. This calculated quantity of stock, by strict mathematics, is not quite sufficient to reach the desired percentage, particularly if the comparatively weak boiled stock is used, but it will be close enough for all practical purposes.

Another method of calculation which requires no reference table and is particularly useful when proprietary dips are employed, is the following: If it is not already known, calculate the quantity of arsenic or concentrate which would be needed to make up an entirely fresh charge of the desired strength. Then determine the fractional part of this quantity necessary to raise the strength of the existing bath to the desired point. For example, suppose 10 gallons of a certain proprietary dip is required for a fresh charge of the vat to the desired strength of 0.18 per cent arsenious oxid, while the strength of the vat actually in the vat is found by test to be 0.15 per cent. Then the bath is too weak by 0.03 per cent, and three-eighteenths of 10 gallons of the dip will have to be added.

In course of time filth and mud will accumulate in the bath to such an extent that the vat will need to be emptied, cleaned out and recharged. Cattle dipped in a bath loaded with filth and mud will necessarily carry out more bath on their bodies, and so more arsenic than they should; also they will dry off more slowly, and very naturally will be more likely to be blistered. By the same line of reasoning some field men of the Bureau of Animal Industry say that after a vat has been charged no more tar or tar stock should be added in replenishing the bath, particularly if work oxen are to be dipped. From experience they have come to believe that tar cements together the filth and mud carried out by the animals and so increases the chance of injury. At any rate it appears to be good practice to reduce the quantity of tar added as the bath becomes dirtier.

On similar grounds is based the important general rule never to use in the spring a bath carried over the winter. Such a bath usually will have become largely oxidized so that when brought up to strength as respects actual arsenious oxid it may be dangerously high in total arsenic. It is at the first one or two dippings in the spring that cattle are most prone to suffer injury, especially when they have come through the winter in poor condition or are still in long hair. They must therefore at least be given the advantage of being dipped in a fresh, clean bath.

PRECAUTIONS IN THE USE OF ARSENIC AND ARSENICAL DIPS.

The fact that arsenic is a violent poison is what renders it valuable, for the fever tick is hard to kill. But, like a keen-edged tool, it may be decidedly dangerous if ignorantly or carelessly handled. Three possibilities of danger must be kept constantly in mind; danger to oneself, danger to other persons, danger to animals.

The dry, powdered white arsenic should be kept in a tightly covered pail, plainly labeled. Paper bags are unsafe because they easily burst, and arsenic so scattered about looks harmless enough. In weighing or otherwise handling the arsenic avoid raising dust or breathing it in, if raised, and keep it off the skin and clothing. In mixing or boiling stock solutions work only in a well-ventilated place, and on the windward side of the kettle so that steam arising from it will not be inhaled.

The stock solutions are in some respects more dangerous than the original substance because the arsenic in them is already in solution and can act very quickly. If any gets on the skin or clothing it must be washed off without delay. Cattle must be kept away from such solutions or from anything that has been in contact with them, for cattle craving salt have been poisoned by licking the outside of leaky barrels and by licking the earth around dipping vats where a little concentrate had been carelessly spilled in charging the vat. All such poisoned earth must be removed, buried and replaced by fresh.

The diluted bath is naturally much less dangerous, but no chances can be taken with it. No puddles from which animals may drink should be allowed to accumulate. The persons who do the dipping should not allow the skin or clothing to be wet by the dip any more or any longer than absolutely necessary. When spraying, the operator should see to it that neither he nor the animals inhale any of the spray.

When a vat is to be emptied the approved practice is to run the waste bath into a pit properly guarded by a fence, where it will gradually seep away under the surface and do no harm, provided

only that seepage can not be carried to a well, stream, or spring from which any person or domestic animal may drink.

The symptoms of arsenical poisoning are rather variable and also depend on the size of the dose and the method of administration. If an animal sickens or dies shortly after dipping it by no means follows that arsenical poisoning or any other effect of the dipping is the cause. Very few cattle relative to the total number dipped have suffered undoubted arsenical poisoning and in most of the cases the cause could be traced to somebody's error or carelessness.

In regard to arsenical poisoning of human beings there is a standard antidote which may be obtained at any drug store with directions for use. It should be kept on hand for emergencies. If the antidote is not at hand the poison must be removed from the stomach by encouraging repeated vomiting, and soothing drinks such as milk, white of eggs and water, or flour and water must be freely given meanwhile. A suspected case of arsenical poisoning must have the attention of a physician at the earliest possible moment, as sometimes the poison works very quickly.

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